

Study examines feeding strategies to increase fresh cow liver glucose output.

Strategies to improve energy metabolism in fresh cows

Many metabolic disorders that occur after calving result from not enough energy intake in the first weeks after calving. During this period dry matter intake (DMI) isn't sufficient to support the high milk production demands of early lactation and leads to a state of negative energy balance (EB). This negative EB results in increased release of nonesterified fatty acids (NEFA) from body fat stores into circulation to be metabolized by the liver. Higher energy intake after calving generally results in lower circulating NEFA and is associated with improved health, performance and less severe postpartum negative EB.

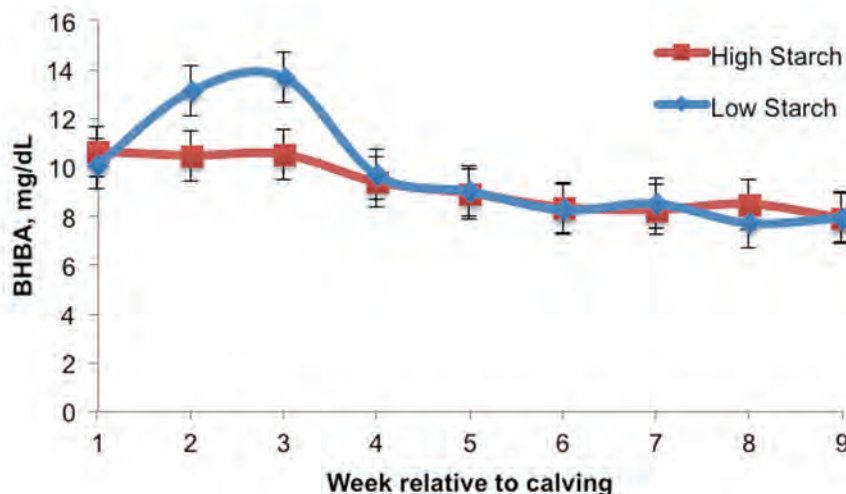
The fresh cow needs to make glucose

The fermentation of starch in the rumen results in the production of propionate, which is the main substrate used to make glucose in the liver. Maintaining a continuous supply of glucose, especially in early lactation, is important for making milk lactose in the

mammary gland. Lactose is an important osmoregulator and is highly correlated with milk yield, so if the amount of glucose that the cow has available for making lactose is increased, she should be able to increase early lactation milk yield, and get off to a better start in lactation. Monensin supplementation increases ruminal propionate, and cows fed higher energy diets after calving and/or monensin during the transition period have improvements in both milk production and postcalving energy metabolism.

It appears that in early lactation when propionate supply to the liver is increased, the liver is more likely to convert that propionate to glucose rather than oxidize it to supply energy for the liver. Animal non-structural carbohydrate intake (mostly starch) in the immediate postcalving period is positively correlated with the efficiency of in vitro propionate conversion to glucose in liver biopsy slice experiments. Together this suggests that the liver has the capacity to direct additional propionate supply to make glucose during the early lactation period.

Figure 1. Feeding early lactation diets with higher starch (26.2%) in the first 3 weeks after calving decreased plasma BHBA concentration compared to cows fed a lower starch diet (21.5%). All animals were fed the higher starch (26.2%) diet from weeks 4 through 9.



More glucose, less negative energy balance

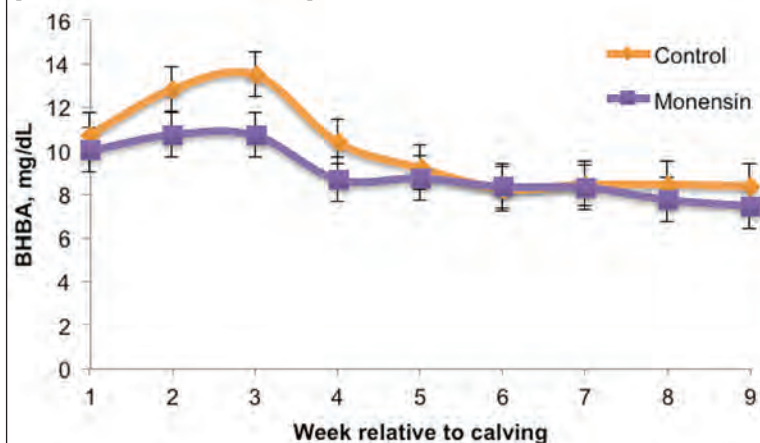
The plasma metabolites NEFA and beta-hydroxybutyrate (BHBA) can be used as markers of negative EB. Allen and co-workers at Michigan State suggest that feeding dairy cows diets that increase ruminal propionate production (e.g., diets high in fermentable starch, monensin supplementation) immediately after calving reduces postpartum feed

FYI

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intake, leading to greater risk of negative EB (e.g. elevated NEFA and BHBA). However, propionate use demand for glucose synthesis elevates during the postcalving period. Liver energy requirements also increase dramatically at the onset of lactation and NEFA mobilization increases. Thus, the intake reducing effect of propionate is likely to be much less in early lactation than at other stages of lactation because of the large increases in liver energy demands and the increase in NEFA supply with the onset of lactation. However, the effect of propiogenic early lactation diets on energy metabolism are not well studied, which was the impetus for this research.

Figure 2. Feeding monensin through the transition period decreased postcalving plasma BHBA concentration compared to Control cows.



The research

The objectives of this study were to evaluate the effect of dietary starch content during the immediate postpartum period and transition period monensin inclusion in diets of differing starch levels on:

1. plasma markers of energy metabolism
2. in vitro hepatic gluconeogenesis

We hypothesized that increasing starch level and/or feeding monensin during the immediate postpartum period would increase liver gluconeogenesis as well as improve measures of energy metabolism, and that the effects of monensin on metabolism would be independent of dietary starch level in the postcalving diet.

Heifers (n = 21) and multiparous (n = 49) Holstein cows were fed a high starch (HS; 26.2% starch, 34.3% NDF, 22.7% ADF, 15.5% CP) or low starch (LS; 21.5% starch, 36.9% NDF, 25.2% ADF, 15.4% CP) TMR beginning at calving until three weeks (wk) after calving with a topdress pellet containing either 0 (Con) or 450 mg/d monensin (M) in a completely randomized design with a 2 × 2 factorial arrangement of treatments. Prior to calving all cows were fed a common controlled energy diet with daily topdress of either 0 or 400 mg/d M consistent with postpartum M treatment. From wk four through nine postcalving all cows were fed HS and continued with assigned topdress treatment until d 63.

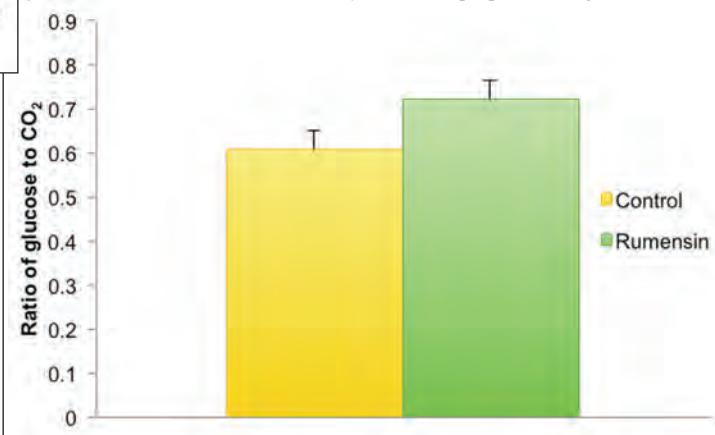
The results

Cows fed HS had higher plasma glucose and insulin and lower NEFA than cows fed LS during wk one to three postcalving. Cows fed HS had lower BHBA during wk two and three after calving compared to cows fed LS (Figure 1).

Cows fed M had higher plasma glucose compared to Con cows, which was driven by a M × parity interaction in which primiparous cows fed M had greater plasma glucose concentrations than Con. Cows fed M had lower plasma BHBA compared to Con (Figure 2), which was contributed to by a M × parity interaction in which primiparous cows fed M had lower BHBA concentrations than Con.

There was no effect of starch or M treatment on liver capacity to oxidize propionate to CO₂ in vitro, and effects of starch on gluconeogenesis were not significant. Cows fed M tended to have greater capacity to convert propionate to glucose than Con. The ratio of the rates of conversion of radiolabeled propionate to glucose and CO₂ provide an index of the efficiency of propionate utilization for gluconeogenesis. Monensin supplementation increased the ratio of glucose to CO₂ (Figure 3), which indicated that cows fed M had a greater propensity to convert propionate to glucose.

Figure 3. Feeding monensin through the transition period had an increased ratio of glucose to CO₂ compared to Control cows, which indicated that cows fed monensin had an increased ability to convert propionate to glucose.



Take home messages

- Cows fed higher starch rations and monensin had higher plasma glucose concentrations and less negative EB.
- Cows fed monensin had an increased ratio of glucose to CO₂ in early lactation, indicating that they had an increased ability to convert propionate to glucose.
- Overall, feeding higher starch diets (26 to 28%) and monensin should increase the cow's ability to make glucose in the liver and improve her energy status after calving. These improvements in energy status should get her off to a better, more productive start to lactation. □